Synchrotron Radiation Instrumentation Collaborative Access Team

SRI CAT NEWSLETTER

Vol. 2, No. 5 July 1996

From the desk of the Executive Director:

There are a lot of ways one can tell that a synchrotron radiation facility is operational. Of course there are the formal ceremonies, such as a big dedication (which we held on May 1) or a final close-out review by your funding agency (which we had on June 18). But the true indication that the facility is operational are the bleary-eyed scientists heading for their cars and leaving for home at 7 or 8 o'clock in the morning. For the last several months this has become a more routine sight around Sectors 1, 2, and 3 of the SRI CAT.

Since my last report, we have had two running periods, the latest one ending on May 24. Stations 1-BM A & B, 1-ID A, B, & C, 2-ID A, and 3-ID A & B have been radiation verified and are operational. (A heroic effort by Mark Keeffe, Bill McHargue, and members of the Engineering and Construction Group in assembling the beamline transports from 1-ID B to 1-ID C permitted us to transport a monochromatic beam into the C station. With our eyes glued to a fluorescent screen located in the 1-ID C station, we opened the monochromatic shutters and, POW, the beam was there on the screen the first time. Not bad, considering we had to thread the beam through 30 meters of transports, shutters, slits, apertures, and Be windows to go from station B to station C.) Station 2-BM A just missed out on its radiation verification due to lack of beamtime but has been rescheduled for the next run, which started in mid-June. Below is a very brief summary of the experimental highlights that went on during the last two runs.

Work on the 1-BM line has been primarily the collection of magnetic dichroism data using a diamond phase plate to produce the required circularly polarized x-rays. The 1-ID beamline has been used to test front-end components (beam position monitors, commissioning windows, etc.), beamline standard components (white beam slits, beam stops, etc.), and high heat load monochromators. A considerable amount of time was devoted to the testing of cryogenically cooled silicon monochromators and, most recently, to room temperature diamond monochromators. Both these approaches gave very encouraging results even at closed undulator gap (11.1 mm) and 100 mA operations! The Sector 2 beamline was utilized for particle beam emittance measurements and undulator spectral properties. These results indicate that the accelerator was operating well below the 10% vertical emittance coupling that was specified in the storage ring design. Also on Sector 2, a series of experiments was performed using a monochromatic x-ray beam focused to less than 1 square micron with a flux in excess of 4×10^9 photons/s. Microdiffraction experiments on a W/Si interface were carried out using this submicron size beam. The nuclear resonant scattering team hit the experimental floor running on Sector 3, testing a gallium-cooled pre-monochromator and high resolution nesting channel-cut monochromator and, using this setup, was able to collect an inelastically scattered phonon spectrum in an FeAl alloy, all in less than two weeks! Several bunch purity measurements were also made by the group in collaboration with the Accelerator Physics Group. Also on Sector 3, the inelastic scattering team was able to test their high resolution nested monochromator setup and use that beam to begin initial tests of curved milli-eV resolution analyzers.

As you can see from my brief account of activities above, a considerable amount has happened in the last three months. Before closing I feel I should mention the APS Dedication that was held on May 1, 1996. A large majority of the SRI CAT members were on hand for the festivities, speeches etc., so I won't recap those activities here. Suffice it to say, with all the food and drink, parties, and most important, old friends and colleagues here to reminisce with, I believe a good time was had by all.

D. Mills, Executive Director, SRI CAT

Who's New

Brian Tieman - Brian recently joined the SRI CAT staff as a Scientific Associate. Brian has been at ANL for six years, coming to us from ATLAS, in the Physics Division. He has experience in mechanical, vacuum, and control systems, which will be drawn upon heavily as he helps us get beamline and experiment systems constructed and tested on Sector 2.

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Australian Use of SRI CAT

On January 17 this year, a memorandum of understanding was signed by the Australian Nuclear Science and Technology Organisation (ANSTO) and the APS formalising the Australian membership of SRI-CAT. This article gives a brief summary of Australia's involvement in synchrotron radiation research to date, and of the expected use of the SRI-CAT beamlines by Australian research groups.

The Australian National Beamline Facility

Australian scientists became regular users of synchrotron radiation in the 1980's, primarily via personal contacts at facilities, and via the various facility general user programs, with the majority of the usage at the Photon Factory. In the late 80's and 1990, an effort was mounted to establish a formal Australian presence at an overseas synchrotron radiation facility, which finally culminated in the construction of the Australian National Beamline Facility (ANBF) at the Photon Factory, which had offered a bending magnet beam port for the beamline. The ANBF project began in 1991 and the beamline became operational in 1993, with all major components being constructed in Australia and transported to Japan for installation. The ANBF is managed by ANSTO as an Australian national facility.

The ANBF was designed as a multipurpose hard x-ray facility. Two monochromators are available: a channel cut with "weak link" detuning, and a fixed exit sagittal focus monochromator based on the Kohzu design. The short length available for the beamline (the diffractometer is 14 m from the source) has precluded the use of a focusing mirror. The beamline has two experimental stations in a single hutch. The primary instrument is a multi-configuration vacuum diffractometer, which can operate using image plates or conventional detectors. It is mainly used for powder, grazing incidence, and triple-axis diffraction, and can also be configured for small- and wide-angle scattering. Figure 1 shows the diffractometer in grazing incidence diffraction mode, with a single image plate loaded in the cassette. When configured for powder diffraction, up to eight plates can be loaded at once, allowing up to 320° of the powder pattern to be recorded in about 10 min. The diffractometer also has a unique time-resolved mode, where large screens shield all but a 5-mm strip of the image plates. The image plate cassette can be moved perpendicular to the beam (similar to a Weissenberg camera) to record over thirty patterns on a set of image plates. Figure 2 shows such a series of patterns. The second station is an optical table which is mostly used for XAFS and XANES, in either transmission or fluorescence mode. A 10-element germanium detector has recently been installed to allow very dilute samples to be measured in fluorescence mode. The optical table has also been used for a range of optics experiments, e.g., characterising focusing capillary optics, micro-CT, and phase-contrast imaging.

The Australian Synchrotron Research Program

The ASRP is a natural extension of the ANBF project. A number of groups are reaching the limits of the Photon Factory brightness and/or energy spectrum, and Australia's very active protein crystallography community, who have continued to use the Photon Factory bio-structures beamlines, are very keen to obtain access to higher brightness sources. A proposal was prepared for funding access to a third-generation source under a new Australian government funding scheme, the "Major National Research Facilities" program, with the APS selected as the most appropriate facility. The ASRP was one of the successful proposals announced in December 1995, with funding granted for five years. Under the ASRP, Australia will join SRI-CAT, BioCARS, and ChemMatCARS at the APS. The ANBF at the Photon Factory will continue to be operated. The ASRP will be managed by ANSTO in much the same fashion as the ANBF, as an Australian national facility. Australia will thus have access to a wide range of synchrotron radiation research capabilities at the APS and the Photon Factory. Furthermore, the experience gained by Australians in the design, construction, and operation of the Photon Factory and APS beamlines will be invaluable if an Australian light source is ever built.

Australia and SRI-CAT

The following is an overview of those Australian groups and their research projects which will immediately benefit from access to the SRI-CAT facilities at the APS.

Sector 1

It seems likely that the major interest in the Sector 1 beamlines, at least initially, will be in time-resolved XAFS. The Australian XAFS community has developed rapidly in the last three years, due to the ANBF, from three or four groups in the early '90s to over ten groups currently. While most of these groups are well served by the ANBF XAFS facilities, a few of the most experienced will be interested in the 1-BM time-resolved station. Dr. Tony Masters of Sydney University, who currently uses the Daresbury time-resolved XAFS station to study the formation, operation, and poisoning of catalysts, and Prof. Russell Howe of the University of New South Wales (UNSW) lead two such groups. There is also interest in Australia in the possibility of performing simultaneous time-resolved XAFS and other diffraction techniques (powder, SAXS, etc.) at 1-BM.

The high energies and multi-purpose nature of the stations of the 1-ID line will also be of interest to some Australian groups. Two examples are: Dr. Evan Gray of Griffith University, who studies hydrogen storage in metal systems by powder diffraction and who finds the 20-keV limit of the ANBF places serious restrictions on his sample dimensions; and Dr. John Davis of Monash University, who has pioneered diffraction contrast CT, which is both count-rate and photon-energy limited at the ANBF.

In the longer term the polarisation program may also attract interest. For example, the ANSTO neutron scattering group, led by Dr. Chris Howard, has had a long involvement in magnetic neutron scattering. Prof. Ted Maslen of the University of Western Australia is interested in vertically polarised beams because they allow the construction of very fast diffractometers, which are

needed for his high-accuracy, small-molecule crystallography.

Sector 2

The Sector 2-ID line may ultimately be the most utilised by Australian groups. Prof. Keith Nugent, who has already visited SRI-CAT, has an active program in phase-contrast imaging and x-ray coherence, and members of his group are active in focusing capillary optics. Dr. Steve Wilkins of the CSIRO Division of Materials Science and Technology has similar interests.

The soft x-ray spectroscopy beamline is also of immediate interest to Australian users. A number of Australian groups are regular users of BESSY, and some are beginning to use the Photon Factory soft x-ray beamlines. In particular, Prof. Robert Lamb of UNSW and Dr. Paul Pigram of LaTrobe University are interested in high-resolution, high-brightness XPS of a range of adsorbate, semi-conductor and insulator systems, and Prof. Robert Leckey of LaTrobe is interested in spin-resolved XPS.

The 2-ID-D microprobe facilities will also attract many Australian users. There are currently accelerator-based microprobes at the University of Melbourne (proton microprobe) and planned at ANSTO (a heavy ion microprobe). Dr. Claudio Tuniz of ANSTO was involved in the original synchrotron microprobe beamline proposal for ELETTRA. The experience of CARS at the NSLS X26 microprobe, and now with GeoCARS, would indicate that there may be a large potential user group of geophysicists and soil and environmental scientists. Informing this group of the existence and capabilities of the SRI-CAT microprobe facilities is an important task for the ASRP management.

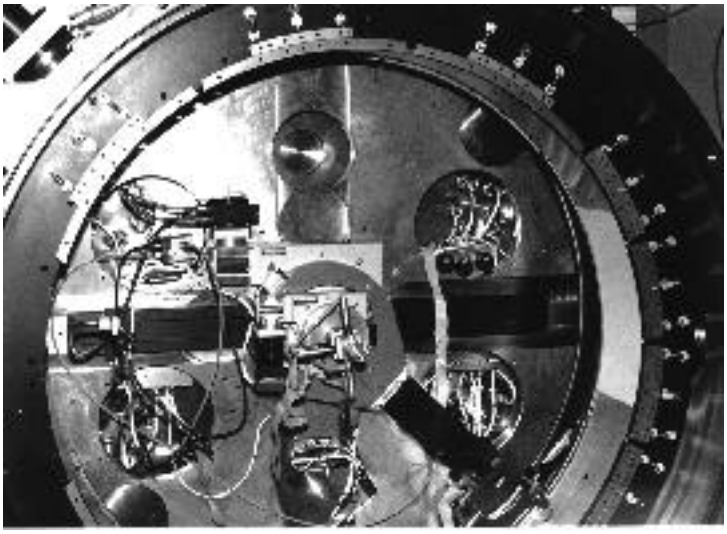

Fig 1. ANBF diffractometer configured for GIXD. The image plate is mounted in a 573-mm radius cassette, so each 100-mm pixel subtends 0.01° in 2-theta. Also visible is the conventional 2-circle goniometer with a thin film sample mounted.

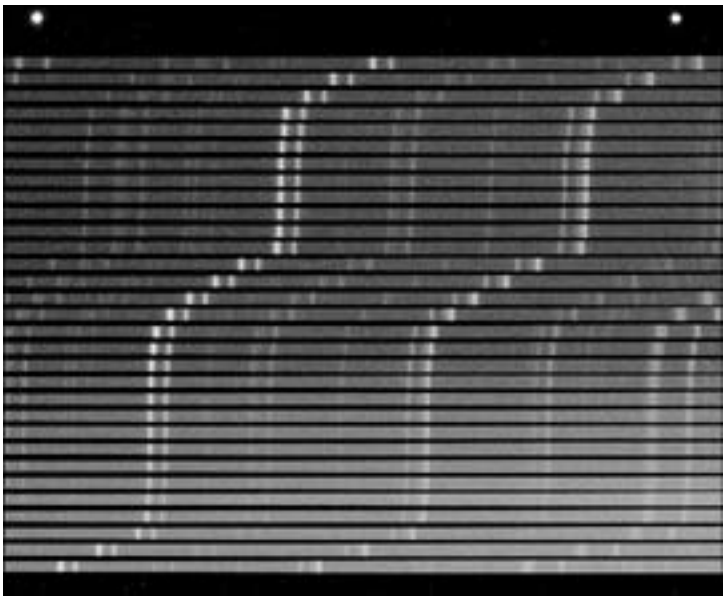

Fig 2. Multiple powder diffraction patterns on a single image plate. The series of patterns is taken at wavelengths from 1.470 Å (top) to 1.381 Å (bottom) from a $YBa_2Cu_3O_7$ Ni doped High-T_c sample. Each horizontal strip is a powder diffraction pattern covering over 40° in 2-theta angle. The powder rings (small vertical line segments) move from one strip to the next because the wavelength step was not uniform. The wavelength range includes both the Ni and Cu edges; the latter can be seen as the increase in fluorescence background about two-thirds of the way down the image. The small dots on the top of the image are fiducial marks produced by americium sources mounted in the image plate cassette.

Sector 3

Australia has an active neutron scattering community, making use of both the HIFAR research reactor at ANSTO and of overseas facilities, principally ISIS, ILL, and IPNS. The high energy resolution and Mossbauer/nuclear scattering facilities being commissioned at Sector 3 are clearly designed to complement inelastic neutron scattering techniques, so it is likely that there will be interest from Australia. Two key members of the Australian neutron scattering community, Prof. John White of the Australian National University and Dr. Howard of ANSTO, will aid in informing the community of the SRI-CAT Sector 3 facilities, as well as being potential users themselves.

Summary

The potential Australian users of SRI-CAT, and their research programs, are likely to develop considerably over the five-year initial lifetime of the ASRP. One of the key missions of the ASRP is to continue the expansion, begun by the ANBF, of the use of synchrotron radiation by the Australian research community, and the membership of SRI-CAT and CARS will see new groups bringing new problems to the facilities over the course of the next five years. *Richard Garrett, Scientific Project Manager, Australian Synchrotron Research Program*

Soft X-ray Spectroscopy at the APS

Introduction

Detailed understanding of electronic structure is of fundamental importance in the material sciences. Conventional spectroscopic techniques, such as absorption, photoemisson, photoelectron diffraction, circular dichroism, and fluorescence, are used in material science programs at all of the current soft x-ray synchrotron storage rings. The increased brilliance of the latest third-generation soft x-ray rings, such as the Advanced Light Source in Berkeley, have made it possible to add new dimensions to many of the conventional techniques by improving spectral resolution, adding spatial or temporal resolution to sample measurements, or making it possible to combine two or more techniques into a single measurement (e.g., spin-resolved photoelectron diffraction). These can result in better defined experimental probes resulting in a clearer understanding of technologically important materials for the next generation of consumer and industrial products, ranging from digital recording media and memory, to catalysts. However, one of the limitations of current third-generation soft x-ray sources is that the undulator source brilliance drops very rapidly above 1 keV. At the same time, interest in the technologically important transition and rare earth metals, or the Si and Al K edges, for example, has recently intensified.

The driving force of the SRI-CAT soft x-ray spectroscopy program is to cover the soft x-ray range from 0.5 to 3 keV with a beam brilliance at the sample comparable to that of an ALS undulator beamline operating below keV. At the same time, the beamline has been designed for high resolution (resolving power ~10^4) and to preserve the polarization of the beam, giving us the opportunity to use an elliptically polarized beam at a later date. In essence, our aim has been to construct a highly versatile beamline for spectroscopic studies of advanced materials, comparable to those found at the ALS, but with an operational energy from 0.5 keV up to the lowest operational energy of the standard APS undulator A at approximately 3 keV.

The soft x-ray (SXR) spectroscopy experimental program will be situated on branchline C of the Sector 2 insertion-device port of the APS. Two undulators will be installed in the Sector 2 straight section: undulator A, which is already installed, will be used for hard x-ray imaging/coherence-related experiments on beamline 2-ID-D/E, and a soft x-ray undulator with a 5.5-cm period, currently being fabricated by Spectra Technologies Inc., that will be delivered in August and installed in October of this year. This undulator will be shared by the soft x-ray imaging/coherence beamline 2-ID-B [1] and the soft x-ray spectroscopy beamline 2-ID-C [2]. Although we originally wanted this device to achieve a 1 keV minimum photon energy, the period was chosen specifically in order to reach 500 eV, which will allow us to cover the important O 1s, Cu 2p, and transition metal L edges. The brilliance of the soft x-ray undulator and undulator A are shown in Figure 1. In the future, we plan to install an elliptically polarized x-ray undulator for polarization-dependent spectroscopic studies. A conceptual design for a fully electromagnetic device already exists, and since this will be a totally new type of device, we are planning to build a 1.5-m-long prototype to test the concept.

Operation of a soft x-ray undulator on a high energy storage ring, such as the APS, has one potentially limiting factor, namely extremely high total power output. Soft x-ray programs at the ESRF and SPring-8 have circumvented this problem from the beginning by using circularly polarized undulators, with inherently low high harmonic production. At the APS, the maximum power output of the 2.4-meter-long, 5.5-cm-period planar device will be 10 kW. For the proposed elliptically polarized undulator, this will decrease to approximately 300 W.

Although the total power output of the plane polarized device presents a formidable problem, we have made significant advances. First, a fixed aperture is used to reduce the on-axis power to less than 1500 Watts, and second, a plane mirror reduces the power on the critical monochromator components to less than 400 Watts [3]. Advanced high heat load instrumentation developed for 2-ID-C includes: (1) a high efficiency "pin-post" cooled silicon mirror is expected to achieve a total slope error of less than two microradians with an absorbed power of 2 kW and power density of 350 W/cm^2 [4]; (2) water-cooled entrance and exit slits, developed as a joint collaboration between the APS and the Advanced Light Source [5], feature a state-of-the-art Glidcop monolith 37 mm thick and 204 mm in diameter that has been electric discharge machined to form a complex flex-hinge structure that produces an extremely precise parallel slit motion. Simultaneously this struc-

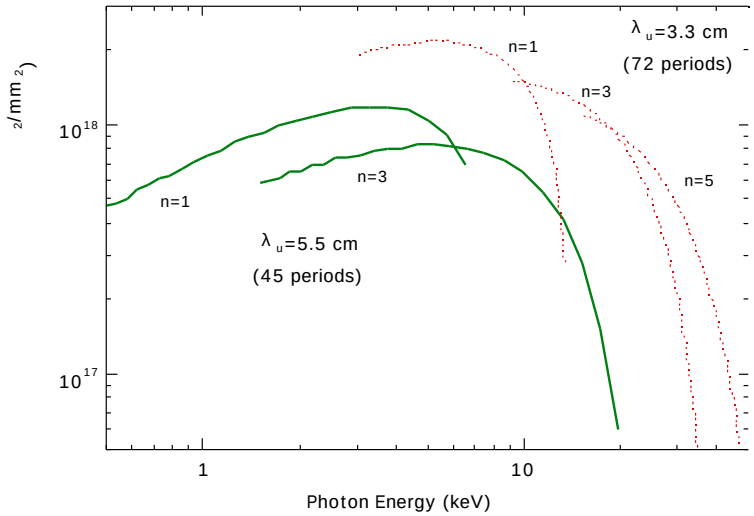

Fig. 1. Total flux (upper curve) of the APS 5.5-cm-period undulator and undulator A, calculated for a storage ring energy of 7 GeV and a current of 100 mA. The 5.5-cm device has 45 periods, the gap is set at 11.5 mm (K=5.67) to give a first harmonic peak at 500 eV.

ture acts as a high thermal conductivity path, removing power from the slit to integral water cooling channels; (3) the monochromator, manufactured by Physical Science Laboratories, features water-cooled gratings and is essentially the same as that installed on the ESRF soft x-ray spectroscopy beamline [6]; and (4) in collaboration with Peter Takacs (BNL) and Werner Jark (Trieste), we are developing an *in-situ* long trace profiler that will measure mirror surface profiles in a UHV environment while the mirror is subjected to high power x-ray beams [7]. One of our goals is to take measurements of the pin-post mirror, with hopes of confirming the exceptionally small thermal deformation indicated by finite element calculations.

Beamline Layout

As manipulation of beam polarization with multilayers or crystals has not been achieved in the 1-2 keV region and because calculations indicate that, at best, phase shifts of only a few degrees will be achievable [8], we must use a variably polarized source together with a polarization-preserving monochromator to expand our program for polarization-dependent experiments. In the present case, we opted for a grazing-incidence spherical grating monochromator (SGM) to achieve high resolution. At the same time, we decided to limit the upper range of the monochromator to 3 keV in the initial phase, since the majority of the scientific program is contained in this energy region, and a double-crystal, e.g., Si(111), monochromator has both higher efficiency and resolving power above 2.5 keV.

An illustration of the major optical elements relevant to the spectroscopy beamline, 2-ID-C, is given in Figure 2. A fixed aperture (FA), acting as a pinhole, with dimensions of 4.5 mm (H) x 4.5 mm (V) is located directly downstream of the shield wall. A plane silicon mirror, M1, at 28 m from the center of the 5.5-cm-period undulator, intercepts the beam with a grazing-incidence angle of 0.15°. This mirror deflects the beam 0.3° inboard, primarily for beamline 2-ID-D, but is shared by all three beamlines. Mirror M2C, at 29.5 m, is the horizontally focusing mirror of the SGM and is used to image the source at the experimental station. The grazing-incidence angle is 1.25°, and a rhodium stripe will be used for the energy range up to 2.6 keV. Because of the limited lateral floor space, a smaller grazing incidence angle could not be used. A multilayer will extend the energy range of this mirror to 3 keV [2]. From measurements we have made at NSLS X8A [9], a nickel-carbon multilayer will cover the 2.6-to-3 keV energy range with a reflectivity of more than 60%. The third optical component in the spectroscopy beamline is mirror M3C, at 39.15 m, with a grazing-incidence angle of 1°. This is the SGM vertically focusing mirror, which has a rhodium coating in addition to the bare silicon substrate. The vertical focusing mirror images the undulator source onto the entrance slit, located at 43.5 m. The entrance slit is continuously variable from 5 to 500 μm. The grating chamber contains three spherical gratings, one of which is selected by a precision linear translation mechanism that intercepts the beam at 47.5 m. The first-order diffracted beam is accepted at an included angle of 176° and is focused onto the exit slit, which translates to track the focal position as the energy is scanned. The exit slit, which is identical to the entrance slit, is at 8 m from the grating and has a travel range of 800 mm in the beam direction. The first experimental station is located at 58 m. A refocusing mirror and second experimental station, which are not shown in this figure, will be added at a later date.

Resolution, Flux, and Harmonic Suppression

To balance the requirements of: 1) high transmission through the entrance slit, 2) maximum resolving power, and 3) minimum exit slit travel range, we have chosen to use a 9:1 vertical demagnification ratio. Given this optical geometry, the predicted total resolving power of the SGM is shown in Figure 3 for three gratings of 600, 1200, and 1800 lines/mm. In this calculation the grating slope error is assumed to be 1 μrad RMS, and the entrance and exit slits are both 5 μm. The exit-slit translation, along the beam direction, is less than 800 mm in all cases.

Assuming a conservative grating efficiency of 5% and taking into account the first harmonic intensity, pinhole transmission, mirror reflectivity, and slit throughput, the intensity at the experimental end station will be approximately 10^{13} photons/s/0.1%BW with a beam size of 1 mm^2. At a resolving power of 5000, we expect an intensity of more than 10^{12} photons/s.

For many spectroscopic applications, it is very important to have a pure first-order monochromatized x-ray beam. Because the SGM, unlike a plane grating monochromator, has no means to eliminate high diffraction orders, we plan to reduce the harmonic content from the source by using the cutoff energies of the mirror coating materials [10]. Reducing the intensity of high harmonics prior to monochromatization will reduce the intensity of high orders at the sample. The calculated suppression of second and higher orders is approximately a factor of 30 to 400 smaller, relative to the first harmonic.

Experimental End Station

We are currently testing a two-tier UHV experimental chamber. This will be used for thin-film and multilayer as well as gas-phase studies. The monochromatized beam will enter the bottom analysis chamber, which is equipped with a Perkin-Elmer hemispherical analyzer with a mean radius of 140 mm, an acceptance angle of ± 20°, a multichannel electron detector, and an electron gun with a 1000-Å beam diameter. The top preparation chamber will be equipped with a reverse-view LEED, an electron gun and hemispherical analyzer for Auger analysis, two thin-film deposition sources, a quartz-crystal thin-film deposition monitor, and an ion sputter gun. Thin-film samples prepared in the upper chamber will be transported into the lower analysis chamber by a precision 600-mm-travel linear manipulator that also has liquid nitrogen and resistive heating capabilities. An electron spin detector will be added to one of the hemispherical analyzers in the near future. In collaboration with the adjacent imaging/coherence beamlines 2-ID-B and 2-ID-E, we also plan to implement a zone-plate-based photoelectron microscope with a spatial resolution of approximately 1 μm.

Because we anticipate problems achieving high reflectivity and low scattered light content, using gratings above 2 keV, we have also designed a UHV soft x-ray reflectometer, which will be used for characterization of optical elements such as multilayer mirrors and

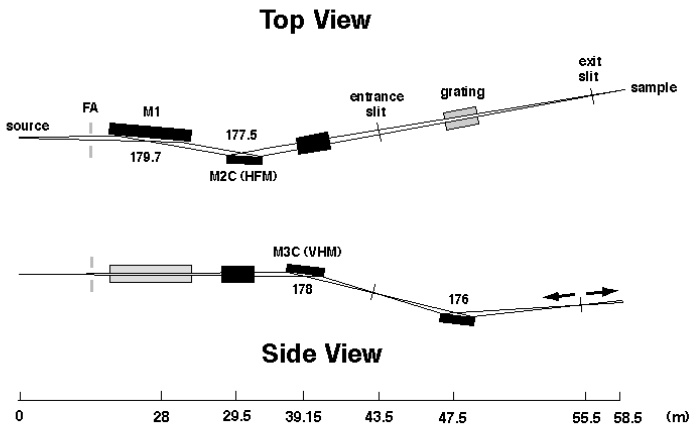

Fig. 2. Layout of the APS soft x-ray spectroscopy beamline 2-ID-C. The fixed aperture (FA) and M1 plane mirror are primarily used as power filters. Mirrors M2 and M3 are the SGM horizontally and vertically focusing mirrors, HFM and VFM, respectively. The positions of the entrance slit, grating, translatable exit slit, and experiment are also shown.

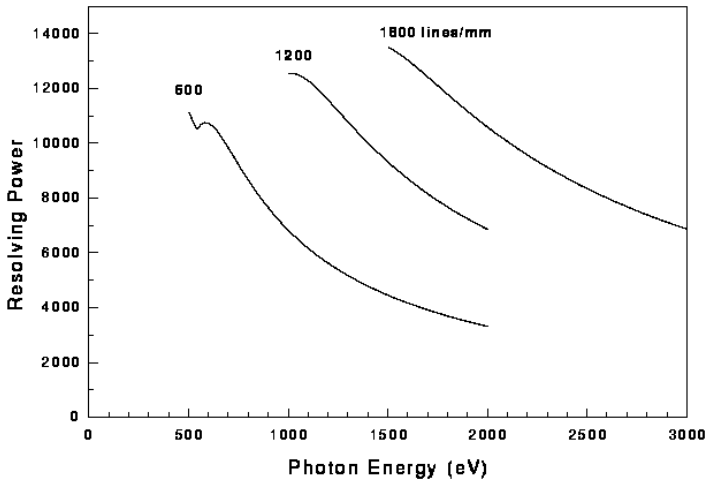

Fig. 3. SGM resolving power with 9:1 demagnification, 10-mm slits, and gratings of 600, 1200, 1800 lines/mm, each with a slope error of 1 mrad. The curves are calculated only for an exit slit travel range less than 800 mm.

gratings. This reflectometer will also have scientific applications including ReflEXAFS and resonant scattering measurements.

Examples of Research Interests at 2-ID-C

As examples of the potential research programs envisioned for 2-ID-C, we would like to present some of our recent results. Experiments that will benefit greatly from a high-brilliance source include photoemission of magnetic surfaces, interfaces and thin films, photochemistry, and high-resolution gas-phase photoemission [11].

Spin-resolved photoemission of thin magnetic films

The properties of bulk magnetic materials have been fairly well studied using conventional magnetic probing techniques, such as neutron scattering and Mossbauer spectroscopy. On the other hand, our knowledge of the magnetic properties of surfaces, interfaces, and thin films is still insufficient because it is difficult to obtain reliable magnetic information on individual atoms for these systems with the conventional magnetic probing techniques.

Spin-polarized x-ray photoelectron spectroscopy (XPS) is both surface sensitive and element specific. Its ability to distinguish photoelectron spin components makes it a particularly useful probe of the magnetic ordering of surfaces, interfaces, and thin films. A long-standing question that remains unsolved is to what extent, in a magnetic system, the core-level XPS spectra reflect the exchange coupling between core and valence electrons. A thorough understanding of such multielectron systems with final-state effects is necessary for obtaining information on the magnetic ground state from the technique.

Due to the complexity of the core-level photoionization process in ferromagnetic transition metals, there have been no theoretical calculations up to now for spin-polarized core-level XPS spectra of magnetic metals that include electron correlation, as well as atomic and solid state effects. On the experimental side, the inherent inefficiency of spin polarimeters makes any spin-polarized XPS studies very difficult. This has been partially compensated by the availability of extremely brilliant insertion device sources operating at the third-generation synchrotron storage rings. In spite of those developments, there are still only a few experimental spectra available so far.

Figure 4 shows an example of spin-integrated and spin-polarized XPS spectra of Fe 3*s* level from Fe/Ag(001) [12]. Fe thin films were grown on Ag(001) single-crystal substrates to a thickness of approximately 20 layers and subsequently magnetized with an adjacent coil. The majority spin spectrum clearly shows a two-peaked structure rather than the single peak observed in the previous studies. The two majority spin peaks are separated by 3.4 eV, which is smaller than that of the early measurements. Moreover, the two spin components in the high-spin ionic state show a separation of 0.93 eV in binding energy, which is not predicated in calculations of the 3*s* multiplet. The results obtained in the present preliminary experiments provide us with some new insights and a better understanding of the problems associated with the core-level spin-polarized XPS.

Photochemistry

Photochemistry represents another subject that will gain from having a high-brilliance soft x-ray source. For a first-order photon-induced process, the reaction rate will be directly proportional to the brilliance. Previously, this

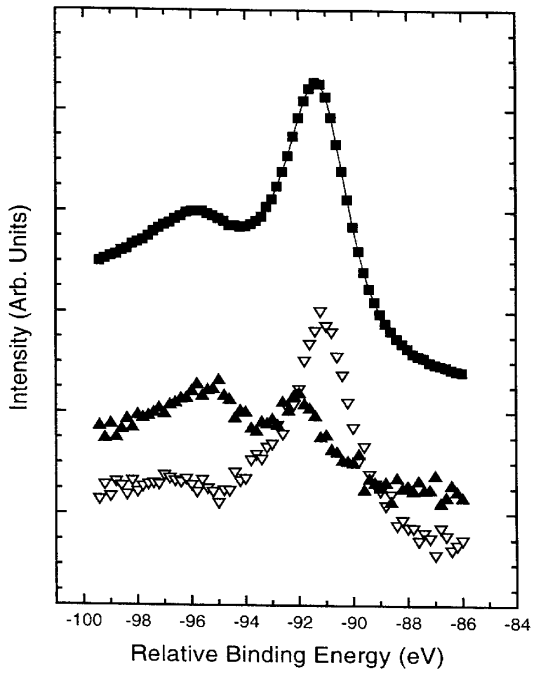

Fig. 4. Spin-integrated and spin-polarized photoemission spectra from Fe. The incident photon energy is 250 eV. The spin-polarized spectra in the bottom halves are indicated by the solid triangles for majority spin and empty triangles for minority spin.

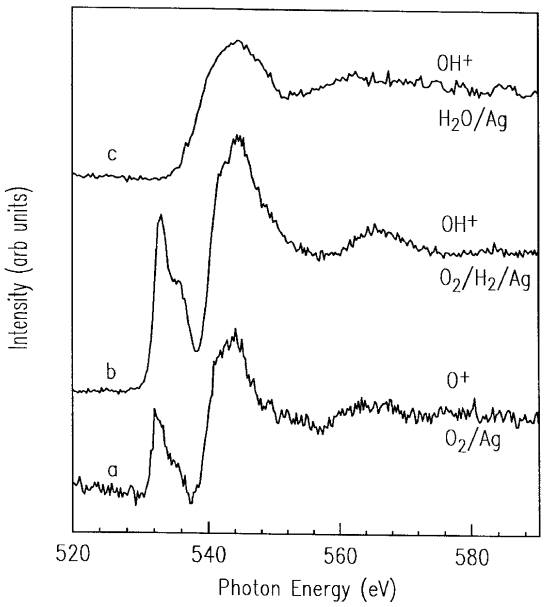

Fig. 5. Three partial-ion yield spectra are shown, for (a) O^+ from a condensed layer of oxygen, (b) OH^+ from a mixed layer of oxygen and hydrogen, and (c) OH^+ from a layer of water.

has largely restricted photochemistry studies to sensitive detection schemes (such as ion detection) or non-monochromatic excitation. In Figure 5, a series of ion desorption mass spectra are shown for condensed layers of (a) O_2 (O^+ detected), (b) O_2 and H_2 (OH^+ detected), and (c) H_2O (OH^+ detected) on silver. Each spectrum was acquired by scanning the photon energy incident on the sample (silver; coated with condensed layers at 5 K) while detecting a particular species with a simple time-of-flight arrangement. Curves (a) and (c) show a simple desorption of a fragment ion resulting from O K-shell excitation in the respective molecules. The initial state of the excitation leading to desorption can be inferred from the shape of the spectrum (in a similar way to absorption spectroscopy). In curve (b), by contrast, the initial O_2 absorption leads to a reaction and OH^+ desorption [13]. Higher energy resolution and state-selected detection schemes (made possible by this facility) will lead to a detailed understanding of the mechanisms of these and more complex reactions, especially pointing to the role of self-trapping, thermal distribution, and secondary electrons in soft x-ray excited reactions.

Conclusion

The combination of the unique energy range that will be covered at high resolution and simultaneously high intensity, together with the future use of circularly polarized x-rays and a broad array of probes available at the experimental end station will undoubtedly make this beamline a unique and valuable resource.

Acknowledgments

We gratefully acknowledge all of our colleagues on Sector 2, in particular, Wenbing Yun, Ali Khounsary, Ian McNulty, Zhonghou Cai, Barry Lai, and Yiping Feng, who have all contributed to the development of the spectroscopy beamline. We would like to acknowledge the conscientious support of Deming Shu, Juan Barraza, Christa Benson, and Joseph Chang in the APS/XFD Engineering and Construction Division. Finally, we would like to thank the external scientific members of the SRI-CAT who have provided a long-term driving force to the soft x-ray program at APS, in particular R.D. Deslattes (NIST) and C.T. Chen (SRRC*). K. J. Randall, J. Z. Xu, E. Gluskin, J. F. Moore, Advanced Photon Source*

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Calendar of Events

August 4-7, 1996
IUCR Synchrotron Radiation Satellite meeting
APS, Argonne National Laboratory, Argonne, IL

August 5 & 6, 1996
High Heat Flux Engineering, Denver, CO
Part of SPIE's 1996 International Symposium on Optical Science, Engineering, and Instrumentation, August 4-9, 1996.

August 6, 1996, 8:30 -10 PM
Synchrotron X-ray Mirror Workshop, Denver, CO, organized by A. Freund, ESRF, and A. Khounsary. Also part of SPIE's 1996 International Symposium on Optical Science, Engineering, and Instrumentation, August 4-9, 1996

August 8-17, 1996
XVII Congress and General Assembly
International Union of Crystallography
Seattle, Washington

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